Regenerative Fuel Cell Test Rig Completed and Operational at Glenn Research Center

The NASA Glenn Research Center has completed construction of its first closed-cycle hydrogen-oxygen regenerative fuel cell (RFC). The RFC is an electrochemical system that collects and stores solar energy during the day then releases that energy at night, thus making the Sun's energy available all 24 hours. It consists of a dedicated hydrogen-oxygen fuel cell stack and an electrolyzer stack, the interconnecting plumbing and valves, cooling pumps, water transfer pumps, gas recirculation pumps, phase separators, storage tanks for oxygen (O_2) and hydrogen (H_2), heat exchangers, isolation valves, pressure regulators, nitrogen purge provisions, instrumentation, and other components. It includes all the equipment required to (1) absorb electrical power from an outside source and store it as pressurized hydrogen and oxygen and (2) make electrical power from the stored gases, saving the product water for reuse during the next cycle.

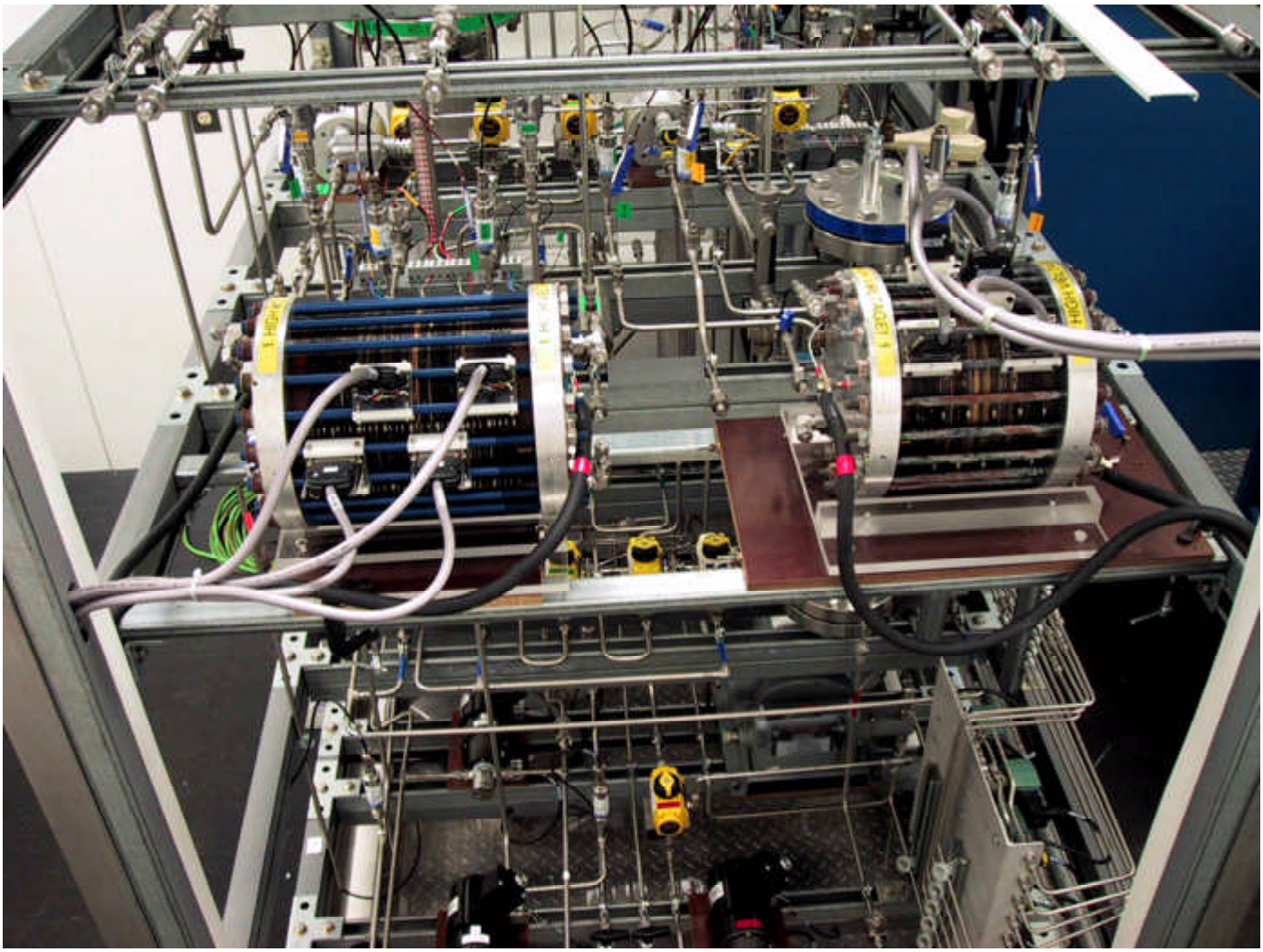
The Glenn RFC is a "brassboard" test rig built from off-the-shelf hardware components. It will be used to

1. Test fuel cells and fuel cell components under repeated closed-cycle operation (nothing escapes; everything is used over and over again).
2. Simulate diurnal charge-discharge cycles.
3. Observe long-term system performance and identify degradation and loss mechanisms.
4. Develop safe and convenient operation and control strategies leading to the successful development of mission-capable, flight-weight, closed-cycle aerospace RFCs for spacecraft and high-altitude aircraft.

Construction was sponsored by the Environmental Research Aircraft and Sensor Technology (ERAST) project of the Flight Research Base Program. The ERAST charter included the development and demonstration of new technologies for unmanned aircraft that are suitable for Earth science, including RFC-equipped solar-electric aircraft with potentially unlimited endurance. Although ERAST was an aeronautics project, RFC energy storage is applicable to a wide variety of space and planetary surface missions in addition to high-altitude solar-electric flight; hence, there is wide-spread interest throughout NASA to bring this technology to a flight demonstration. Potentially the highest storage capacity and lowest weight of any nonnuclear device, a flight-weight RFC aboard a solar-electric aircraft that is flown continuously through several successive day-night cycles will provide the most convincing demonstration that this technology's widespread potential has been realized. Leading up to the flight demonstration are several laboratory and full-scale demonstrations of key components and subsystems, including the

coordinated operation of a hydrogen-oxygen fuel cell and electrolyzer as an energy storage system in a sealed, closed-loop environment (the venue provided by this brassboard RFC).

The Glenn RFC was built up over calendar years 2002 to 2003 and was operated as an end-to-end energy storage system for the first time in September 2003. Additional characterization tests, and the next generation of fuel cell and electrolyzer stacks, will take place during 2004 and 2005. The photograph shows the integrated equipment assembly (IEA) at Glenn, with fuel cell and electrolyzer stacks shown in the foreground.



RFC-integrated equipment assembly at Glenn.
The "guts" of a hydrogen-oxygen regenerative fuel cell. Fuel cell and electrolyzer stacks are directly in the foreground; behind them are the numerous ancillary components.

Find out more about NASA Glenn:
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